# Improved Eddy Current and FPI for Rotatable Engine Components

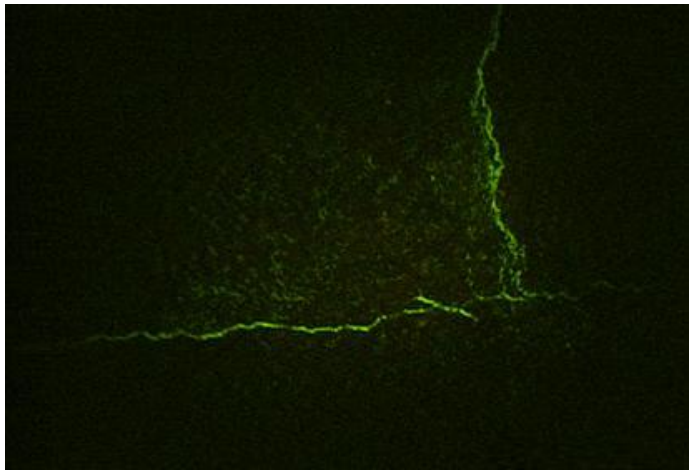
Product Technology Showcase

**David (Dak) Stone**:
Director of Business Development
**Canyon Run Engineering Technologies**

CANYONRUN
ENGINEERING TECHNOLOGIES

# Agenda

- Canyon Run Engineering Technologies - Who we are
- FPI with the Deep Well Spool Inspection System
  - Challenges
  - Canyon Run System
- Improved Eddy Current with Automated Cleaning
  - Challenges
  - CR System



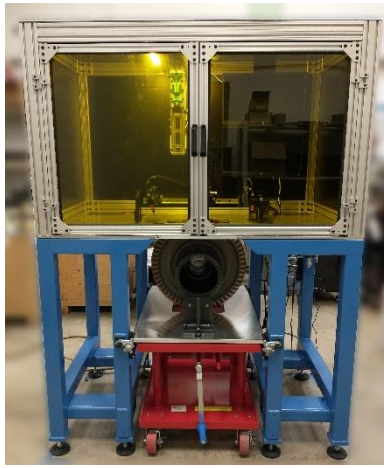
*FPI Image*

*Aviation Powerplants*

# Canyon Run: Who we are

Founded in 2014: Canyon Run Engineering Technologies is a turnkey business solutions provider. We are a team of subject matter experts that together deliver Manufacturing Solutions, Inspection equipment, R&D, Automation and Mechanical Systems to the Aerospace, Medical Device, Defense, and Consumer Electronic industries.

Our clients consist of small businesses and start ups to Fortune 100 companies

*Laser/Machining Blade Processing System*

*ECT Robotic Probe End Effector*

*Materials Handling Equipment*

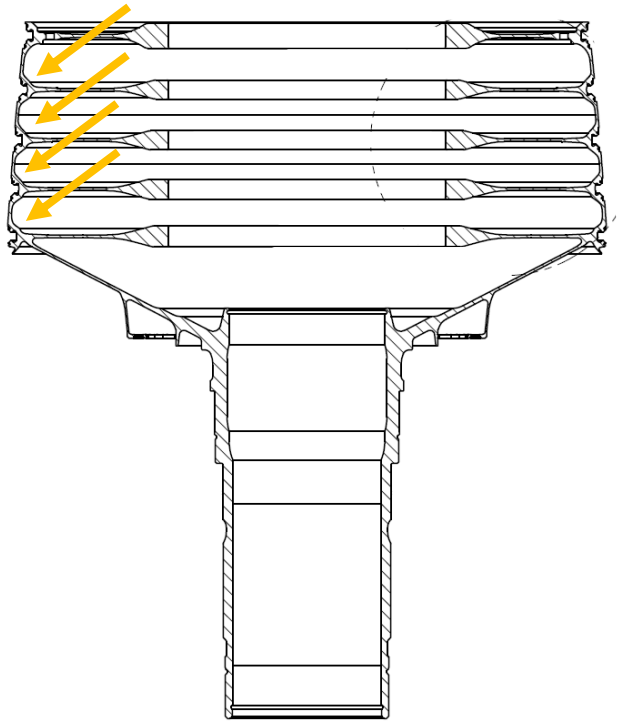
NEXTGEN
AEROSPACE TECHNOLOGIES

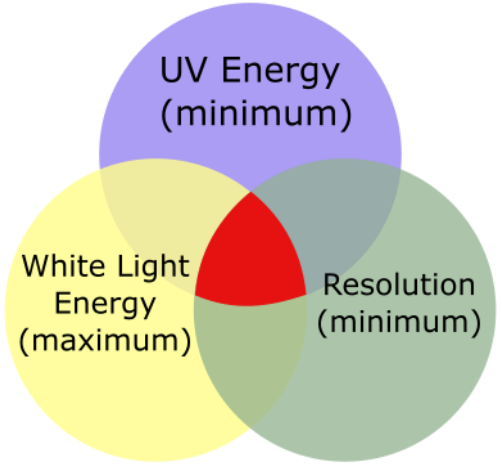
# FPI with the Deep Well Spool Inspection System

# FPI of Deep Well Spools and Blisks

**Challenges**

- LLP - Life Limited Parts
  - Inspection of rotatable engine components
  - High risk
  - Difficult visual access
- New and existing industry requirements – *Maintain the overlap of the following*
  - Minimum UV energy requirements (uW/cm²)
  - Maximum light "pollution" requirements (lx fc)
  - Minimum resolution requirements (ip/mm)
  - 100% inspection of difficult to reach areas
    - Spacer arms
    - Web surfaces
  - Part Indexing





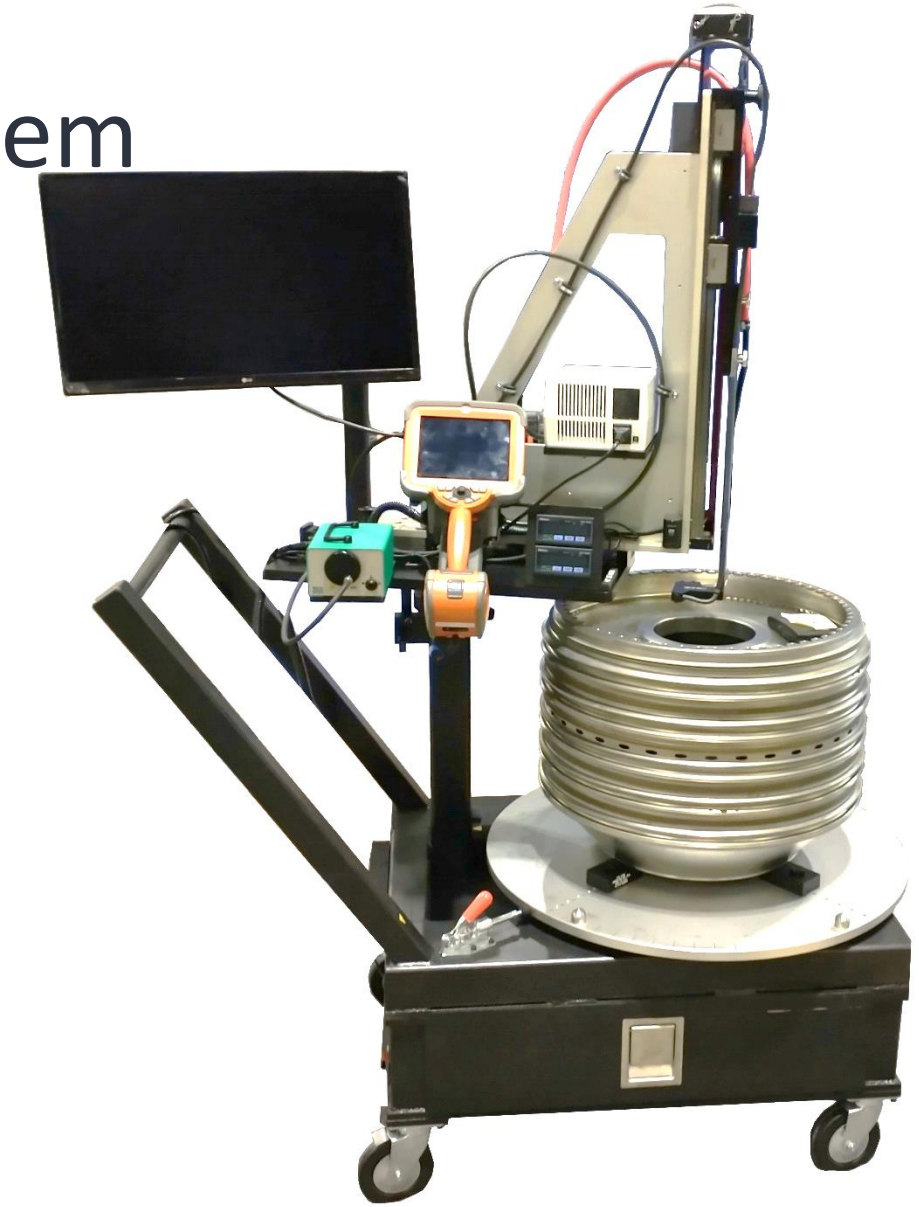

**Industry & OEM Standards**

ASTM E1417 / E1417M-16
EN ISO 3059 / ISO 3452-1:2013
*GE Aerospace:* **SPM 70-32-02**, P3TF44, P3TF47
*Rolls Royce:* RRES 90061
*Pratt & Whitney*: PW SPM 70-33-00
…

# Deep Well Spool Inspection System

## Solution

- Integrated MVIQ – Waygate Technologies
  - UV and white light visual inspection capable
  - Stereo measurement capabilities
  - Digital ecosystem
- Fixed inspection arm for accessing cavities
  - Fixed viewing optics
  - Access of 100% spacer arms, radii, web surfaces
- Controlled measurement axis
  - Rotational and linear
  - Indexing part relative to camera in multi-axis
- Complete operator control



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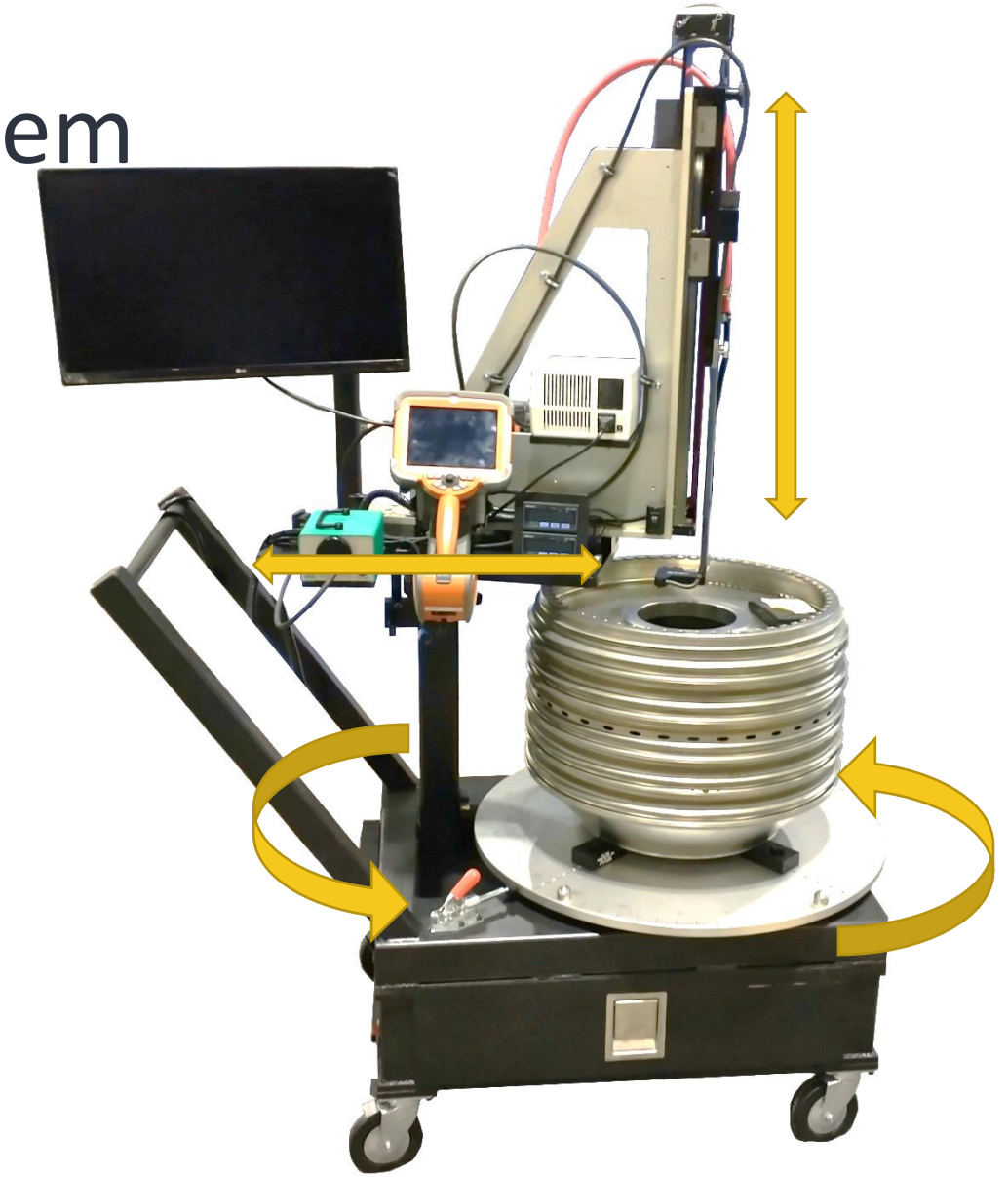

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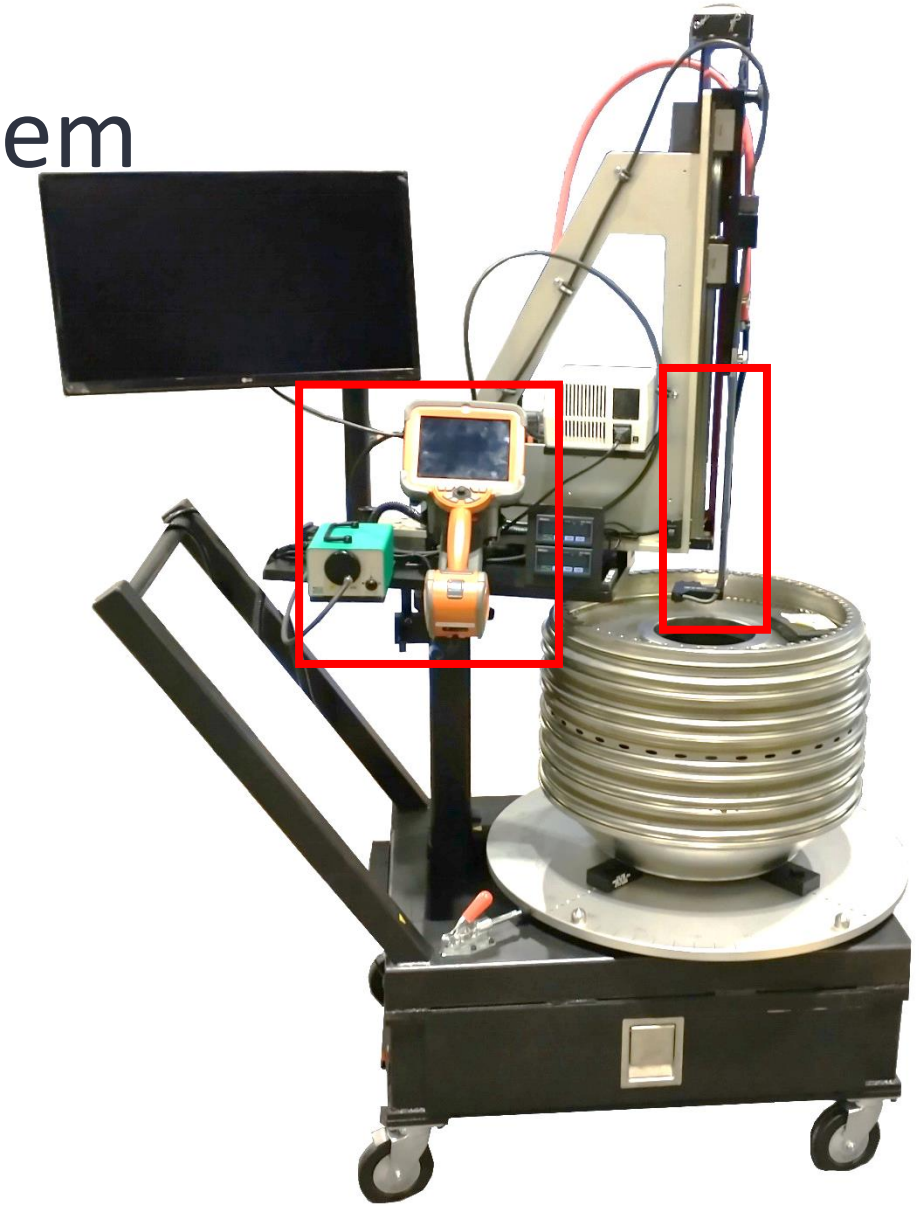
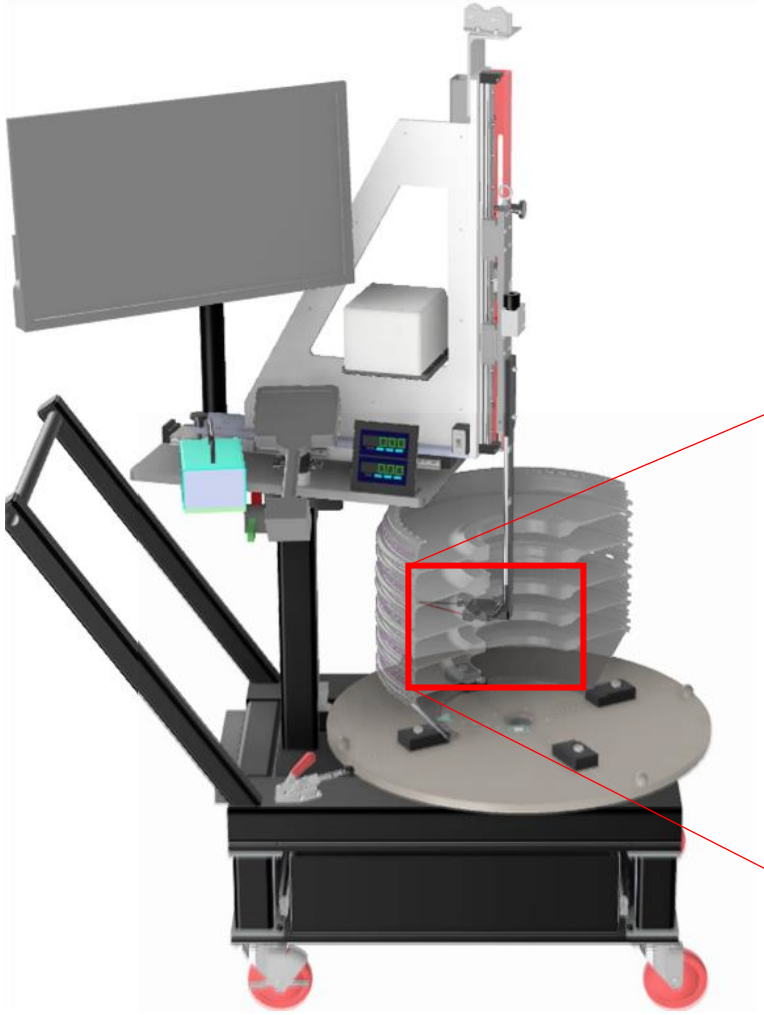
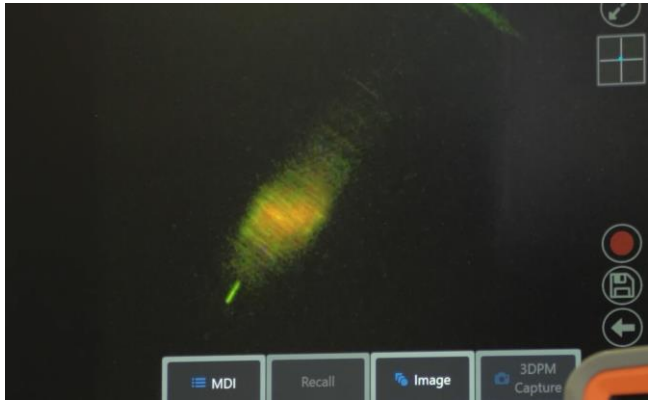


# Interchangeable Inspection Arm

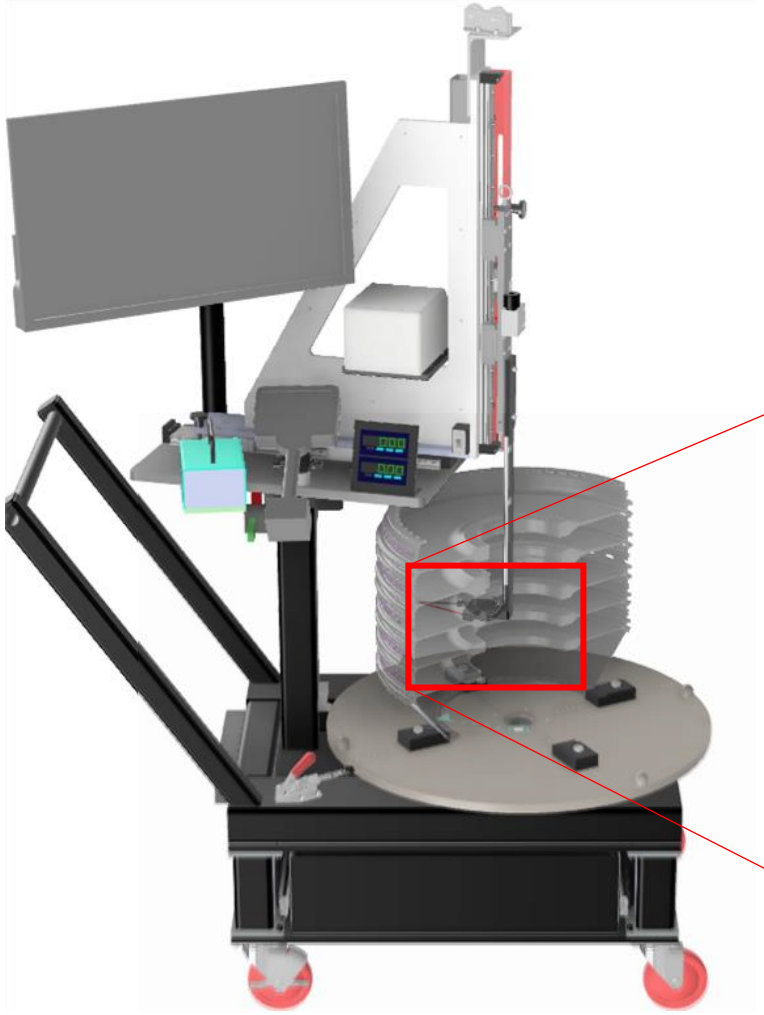


- Changeable arm to reach required distance to spacer arms of various engine lines
- Houses UV inspection probe and white light for visual inspection
- Off angle light guide and diffuser for improved no-glare white light inspection


Indication Inside Spool

# Interchangeable Inspection Arm



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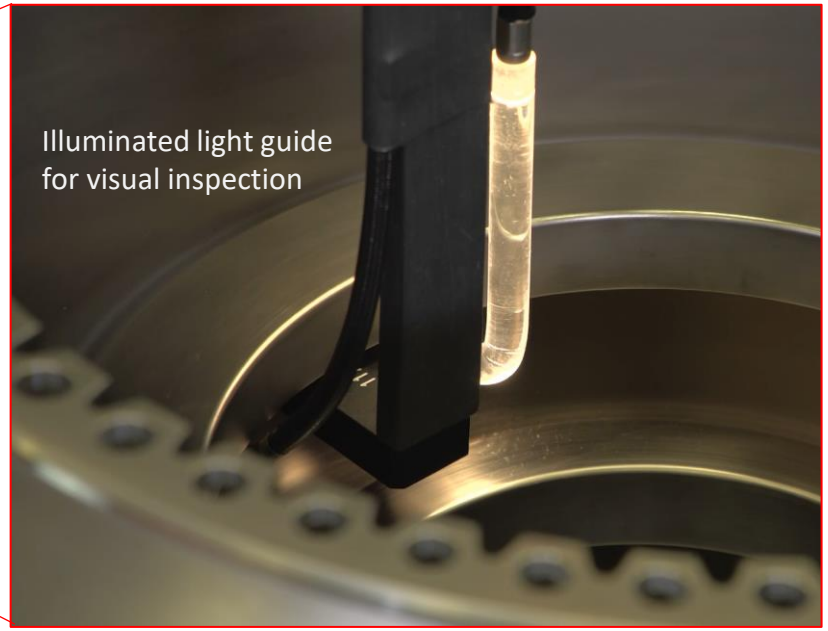
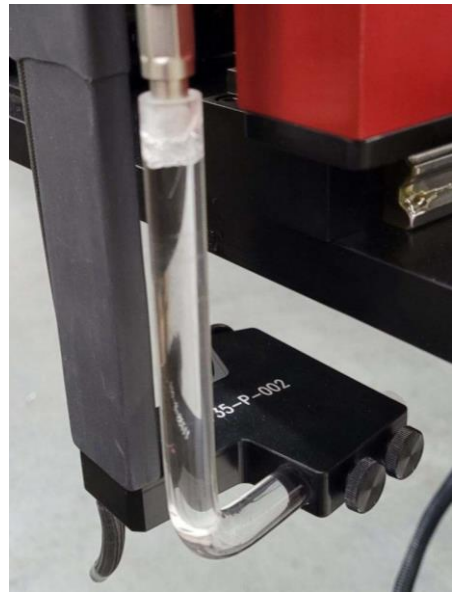


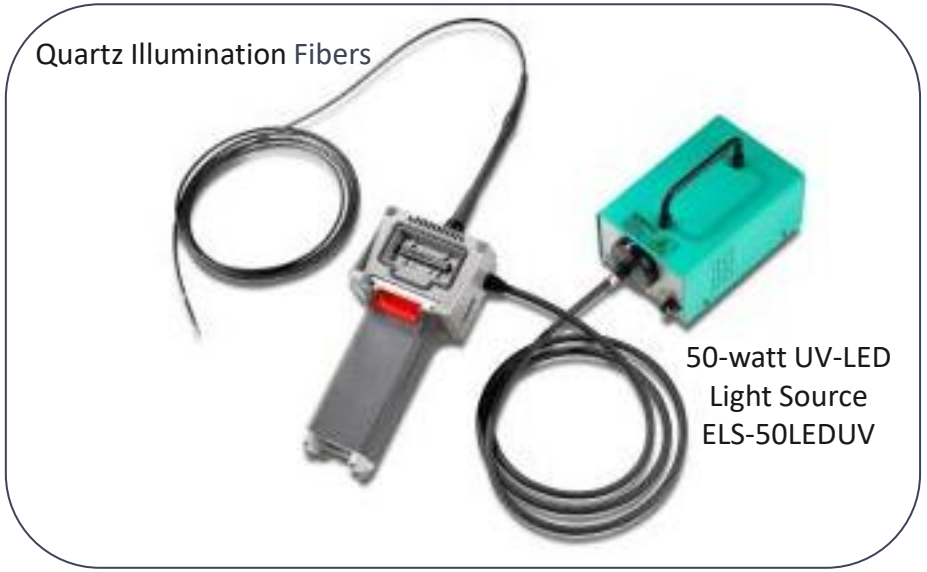
Off Angle Light Guide

Waygate Technologies
a Baker Hughes business

# MViQ – UV VideoProbe

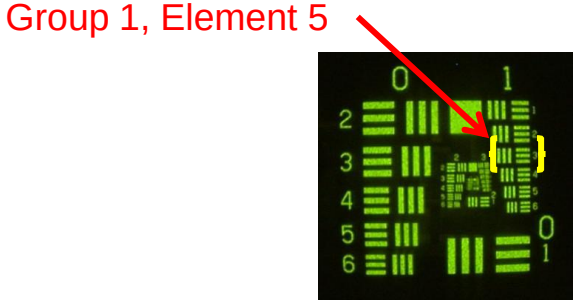
# FPI / UV Configuration

**UV / White light Switchable**
**Stereo Measurement Capable**




Meets Requirements

1. App: Remote Video Monitor
2. App: Forward, 45°, and 90° viewing angle for 100% inspection area and overlap
3. UV: At least 1200uW/cm$^2$ UV energy on target
4. WL: Less than 2 fc white light on target
5. Res: At least 3.17 lp/mm resolution (USAF-1951 G1/E5)
6. Res: Accurate to within ±0.002”




Fluorescent USAF 1951 Test Target

Waygate Technologies
a Baker Hughes business

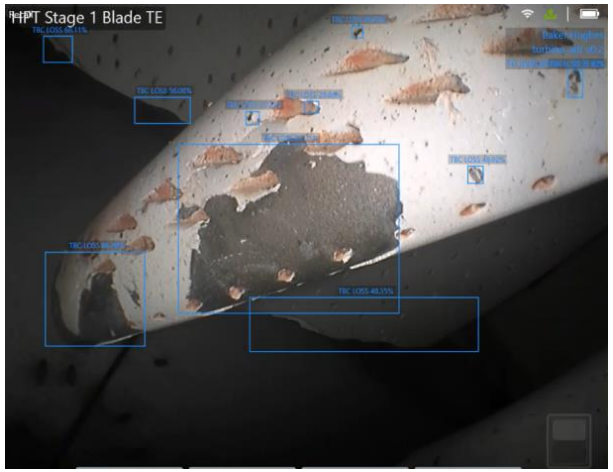
**UV / White light Switchable**
**Stereo Measurement Capable**


Typical **Deep Well Spool** UV Inspection Image
8.4mm Forward Black **Stereo** Tip
0.280" Tip-To-Target

Measurements (Linear)

- 3D Stereo measurements
- *Traditional stereo measurements*
  - *UV measurements are not available with 3DPM techniques*

Waygate Technologies
a Baker Hughes business




ADR - Assisted Defect Recognition

## VideoProbe Digital Ecosystem

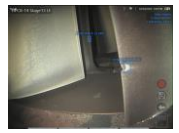
Data lake
MRO
LDP
Air Carrier
...

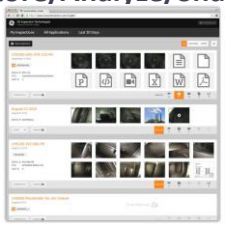
Customer SW Infrastructure

API

Store/Analyze/Share

ADR



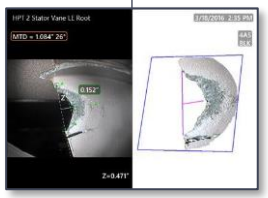


InspectionWorks Cloud Services

MDI Builder
Condition Based Inspection

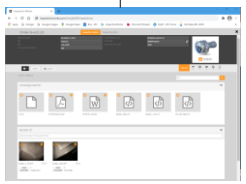
Pre-Inspection → Inspection → Post -Inspection

InspectionWorks Connect
Live Collaboration

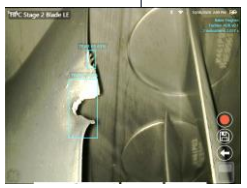


3D Measurement

MDI App
Capture & Reporting



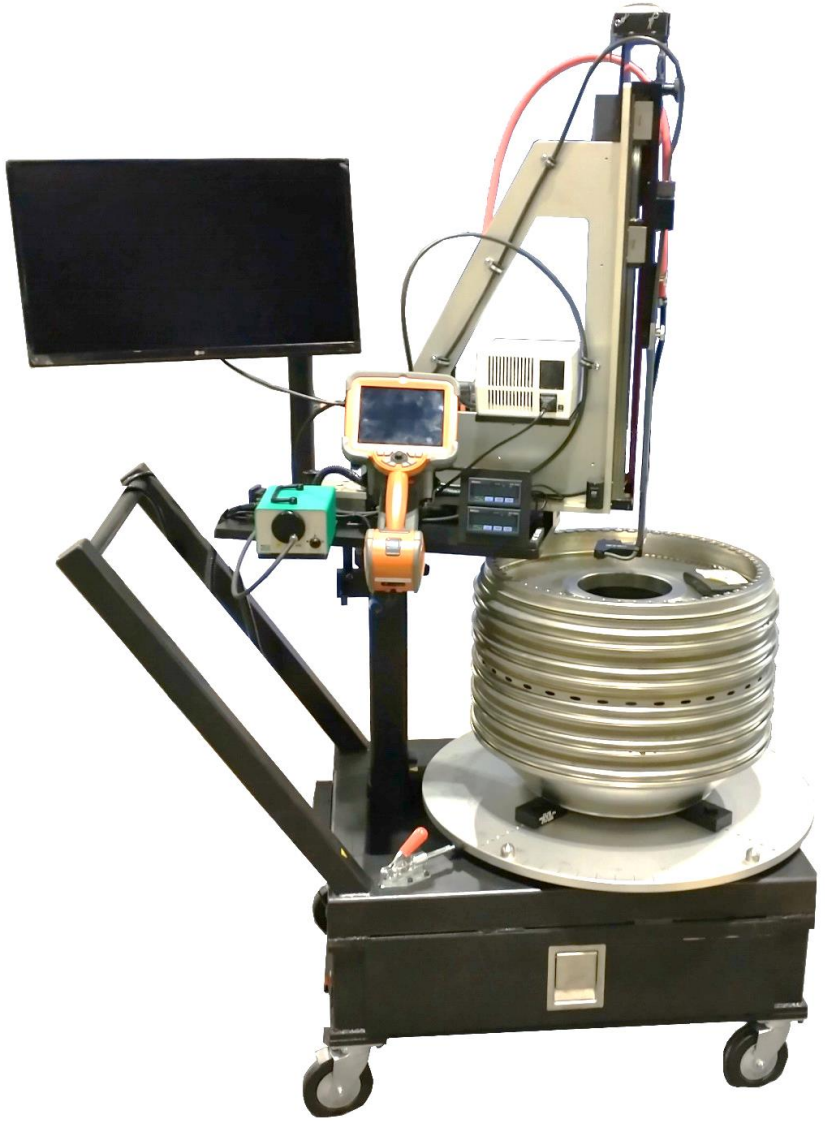
Prior Inspection Access



ADR

# Summery

- Included in GE Aviation ESMs
- Meets most Industry and OEM requirements*
- 100% coverage
- MVIQ *(Waygate Technologies)*
  - White light and UV inspection
  - High resolution stereo measurements
  - Digital Ecosystem – Pre/Post, Cloud, ADR…
- For inspection of rotatable components
  - Spools, blisks, fan disks…



# Improved Eddy Current with Automated Cleaning

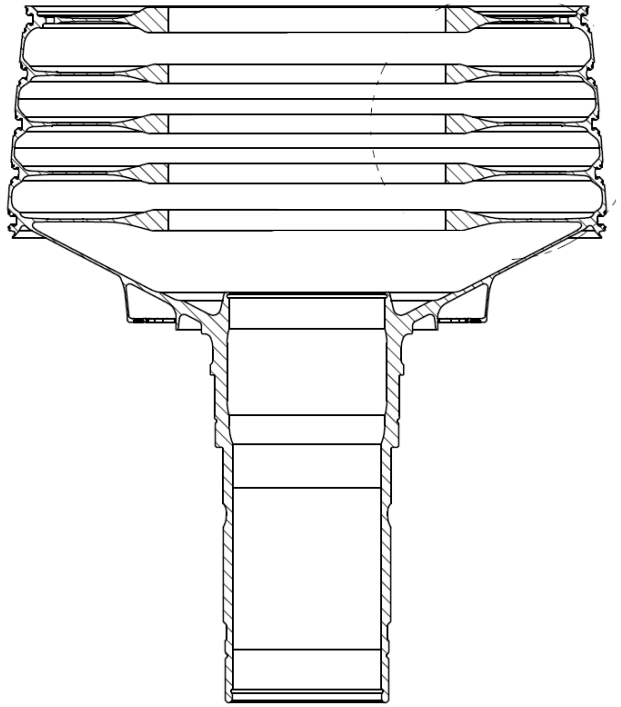
# Improved Eddy Current with Automated Cleaning

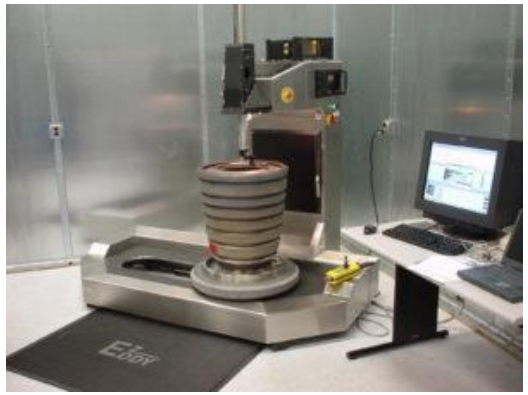
**Difficulties**

- LLP - Life Limited Parts
  - Inspection of rotatable engine components
  - High Risk
  - Difficult access for manual clean procedures

- ECT of difficult to reach areas
  - Spacer arms
  - Web surfaces
  - Cones surfaces on shaft connection

- Clean process issues
  - Typically done by operator by hand
  - Manual cleaning process time: **4-6 Hrs**
    **(32 Hrs in some cases)**
  - Re-inspection of hand scrubbed parts
  - Possible rejection of good parts
  - Build up leads to probe lift off (mV range >40%)
  - Potential damage to probe





*EZ-Eddy Eddy Current Scanner*

*Motoman Eddy Current Cell*

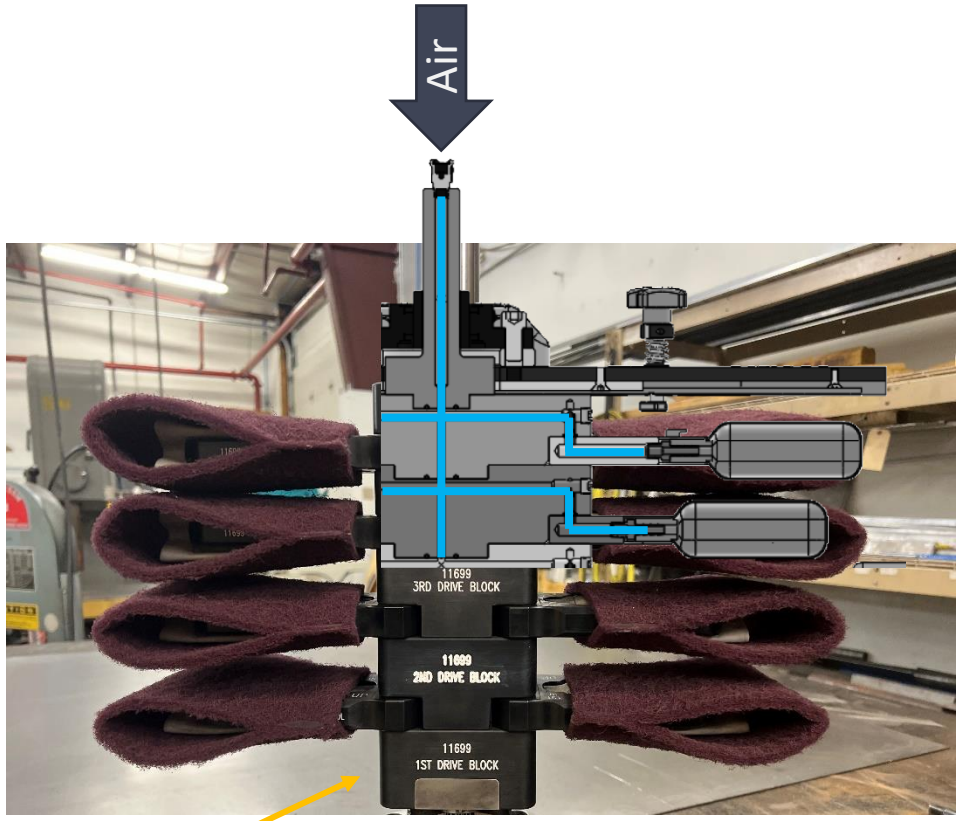
# Automated Spool Polishing System

**Solution**

- Automated internal cleaning
  - Pneumatic air bags
  - Consumable scouring / cleaning pads
  - Slow timed rotation – no blending of cracks
  - Non aqueous
- Cleaning time of 10 minutes vs 4Hrs
  - Access difficult areas
  - Prevents terminated scans due to false negative readings
  - Reduced lift off errors

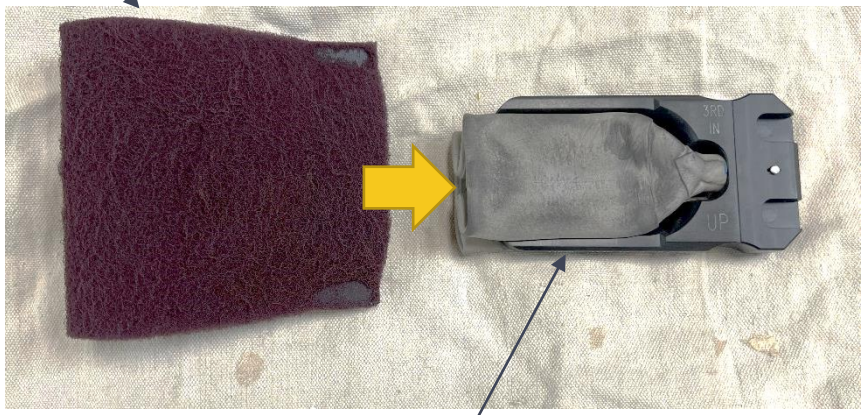
*Patent Pending

# The Pneumatic System



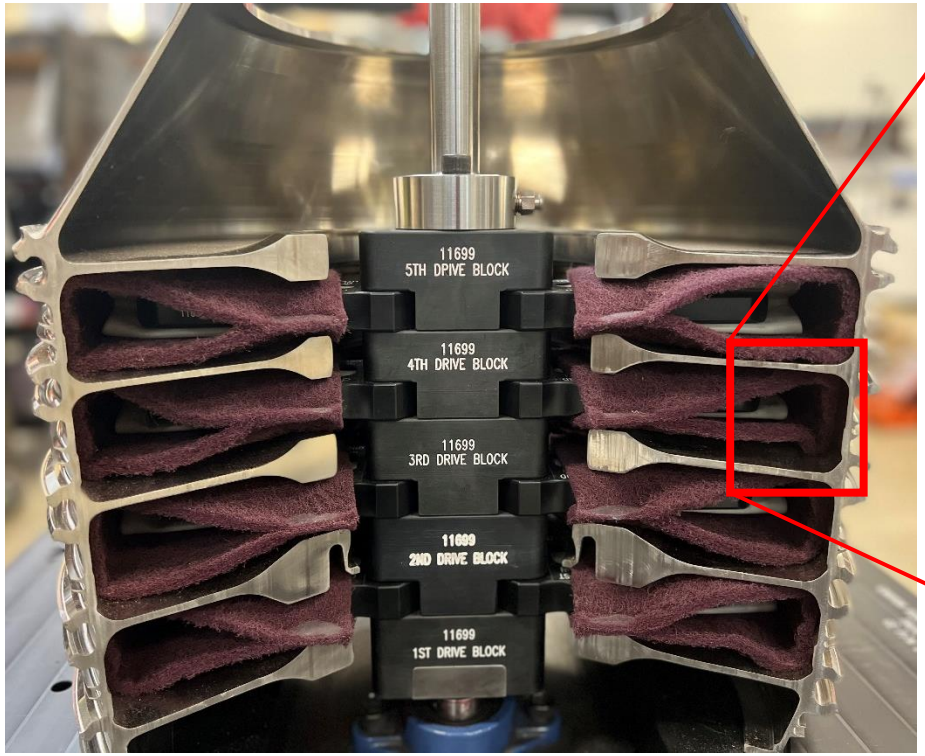

Independent Stages

Approved scoring material:
Red Scotch Bright

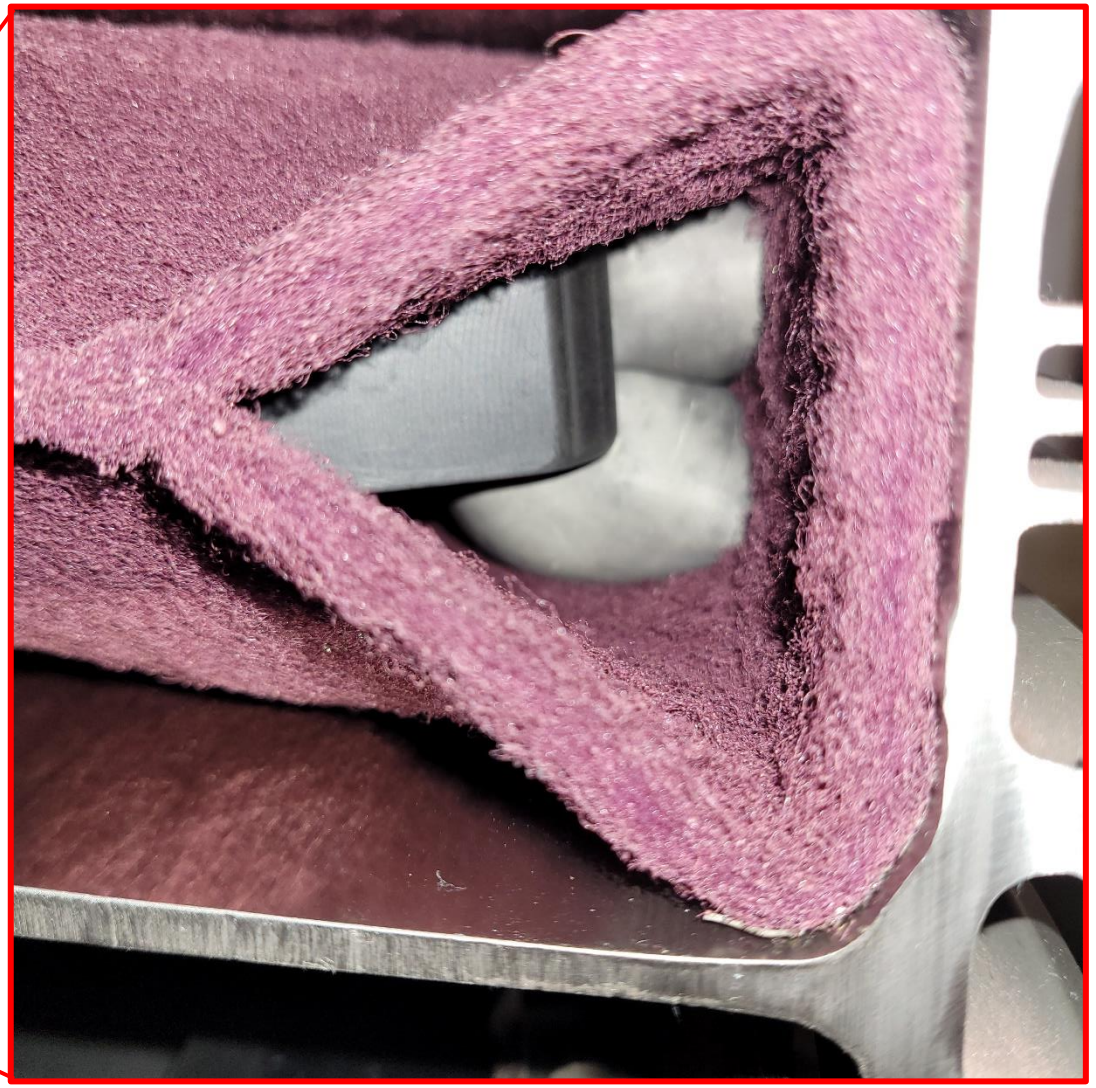


Air bag and rigid paddle

# Paddle Designs




Spool cross section with assembled polishing tree



Inflated pneumatic spacer arm radii assemblies

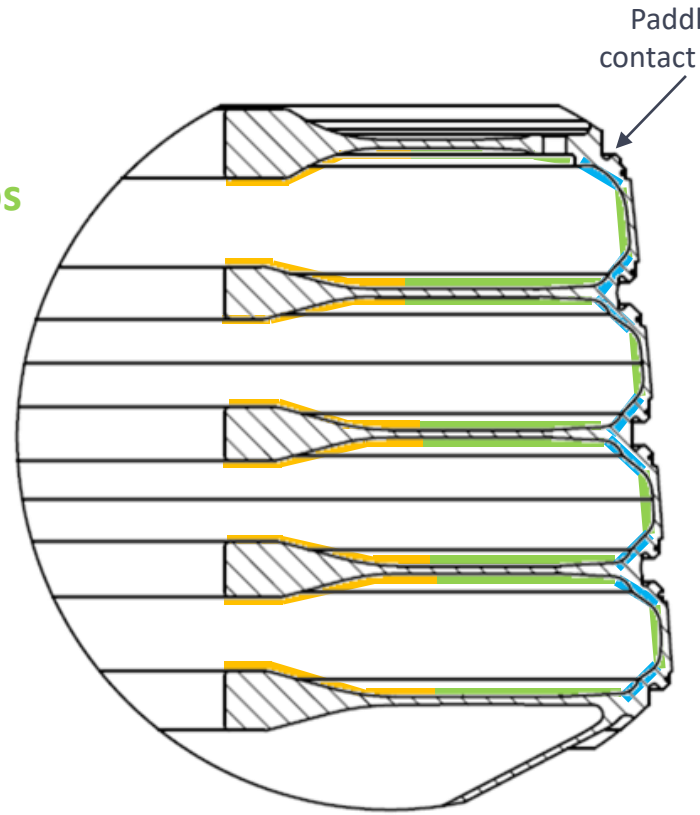
# Paddle Designs


**Paddle Design 1 – Spacer Arms and Webs**

**Paddle Design 2 – Bore Face**

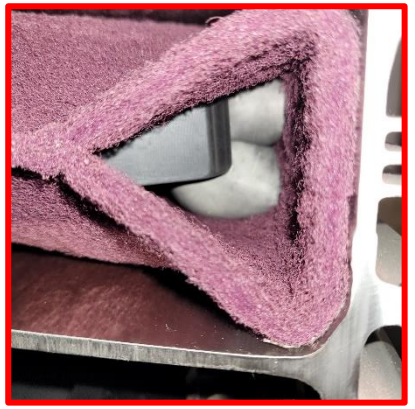


**Paddle Design 3 – Radius**

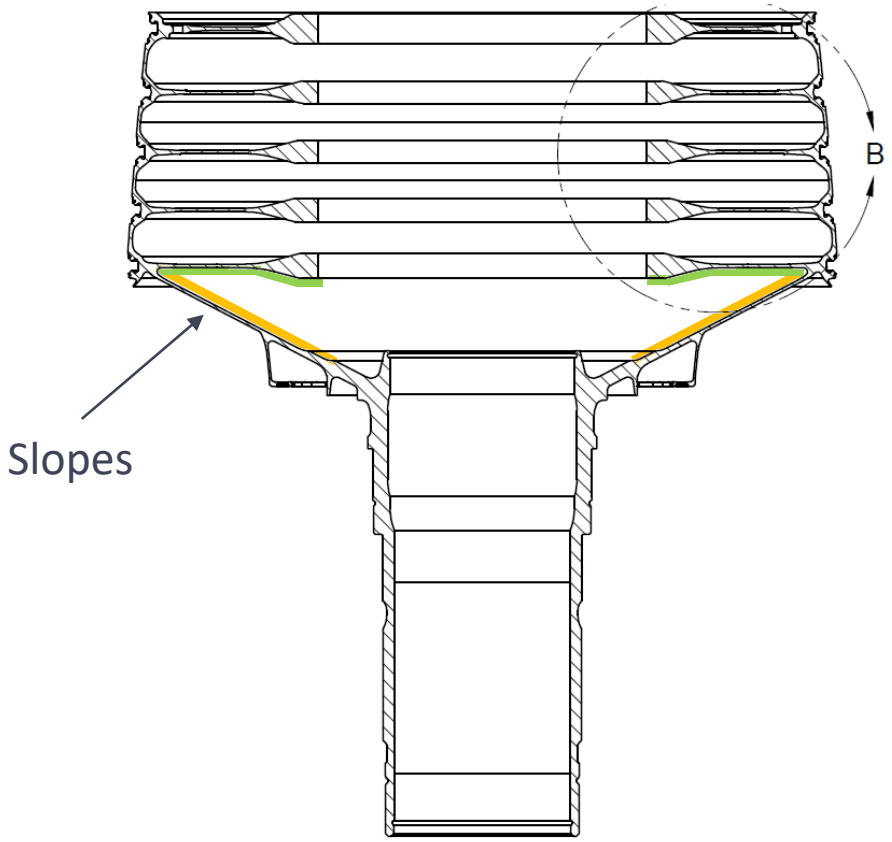



| Paddle | Contact surface Color |
|---|---|
| Paddle Design 1 | Spacer arms and Webs |
| Paddle Design 2 | Bore Face |
| Paddle Design 3 | Radius |

Paddle and corresponding contact surface



# Difficult areas and Specialty Paddles

# Difficult areas and Specialty Paddles

- Small components
  - Bore size access limitations
  - Spacer arm spacing too narrow for manual access


Hinged Paddle Design for Small Bore Spools

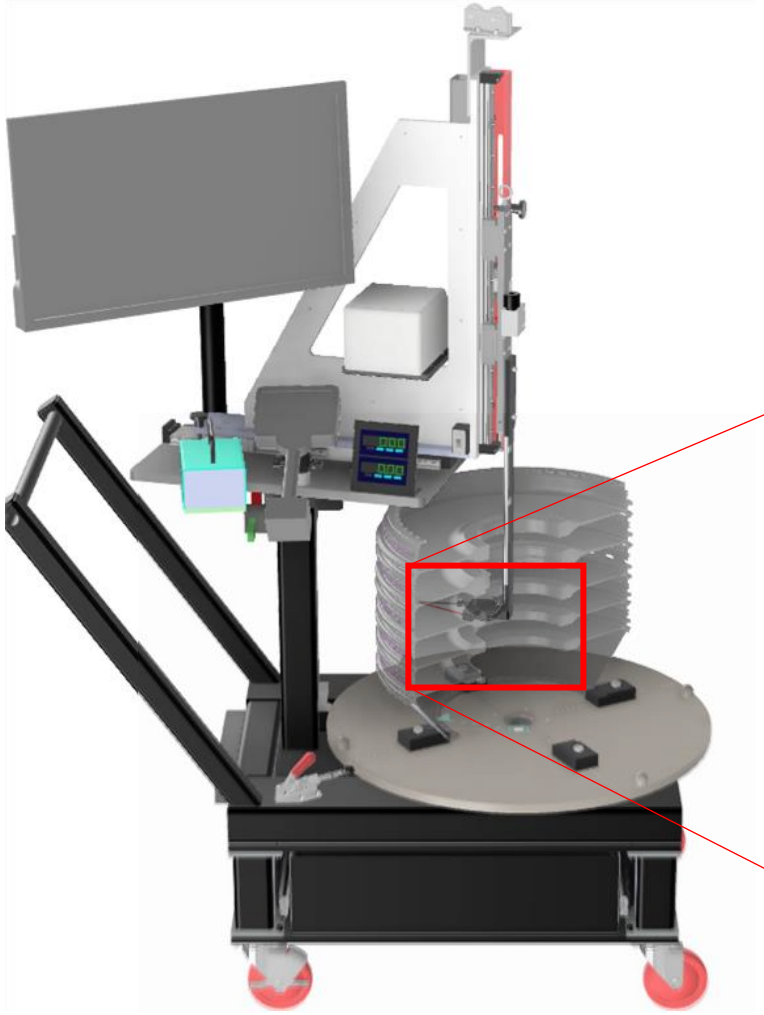
# Summery

- Included in GE Aviation ESMs as approved cleaning method
- Cleaning time of 10 minutes
- 100% internal surface cleaning
- Repeatable cleaning method
- Also adapted for FPI
  - Cleans required surfaces
  - Same tooling as used in the Deep Well Spool Inspection System

# Thank you!

**David (Dak) Stone**:
Director of Business Development
David@crengtech.com
O: (937)-335-0496
C: (614)-632-4717

# Interchangeable Inspection Arm



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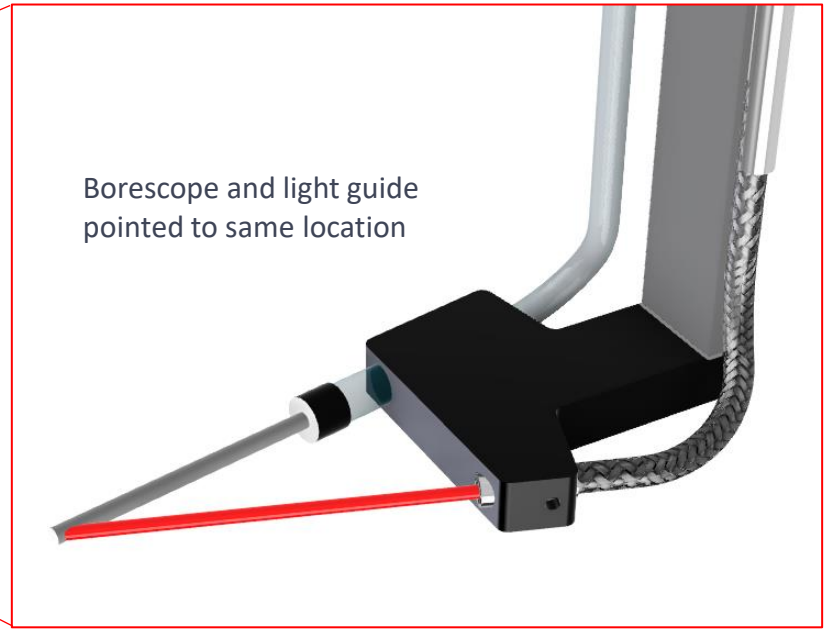
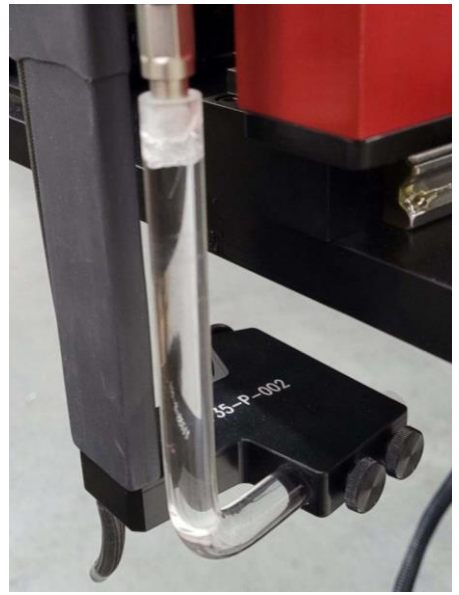


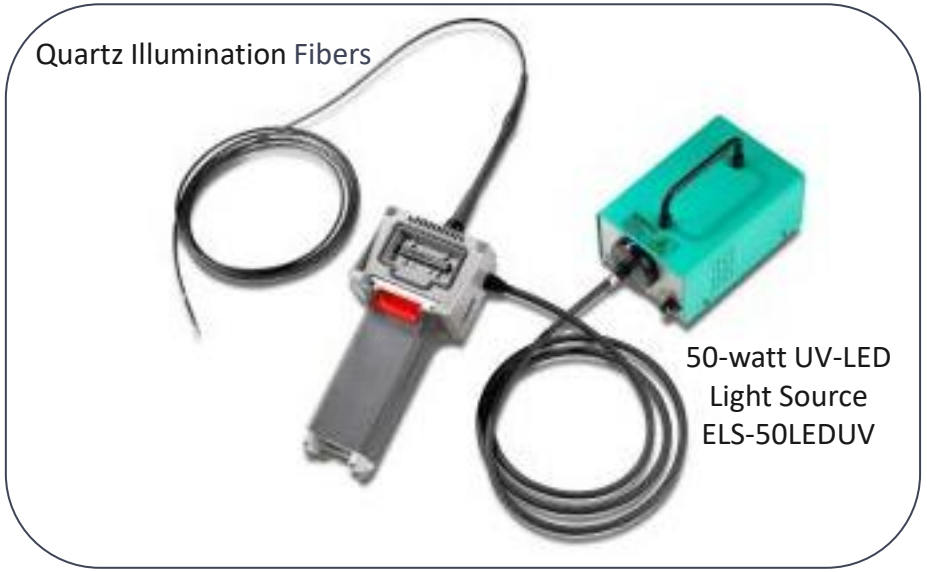



Off angle light guide

Waygate Technologies
a Baker Hughes business

# MViQ – UV VideoProbe

# FPI / UV Configuration




**UV / White light switchable**
**Stereo measurement capable**

Customer Requirements

1. App: Remote Video Monitor
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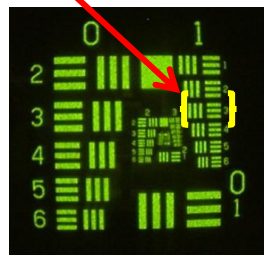
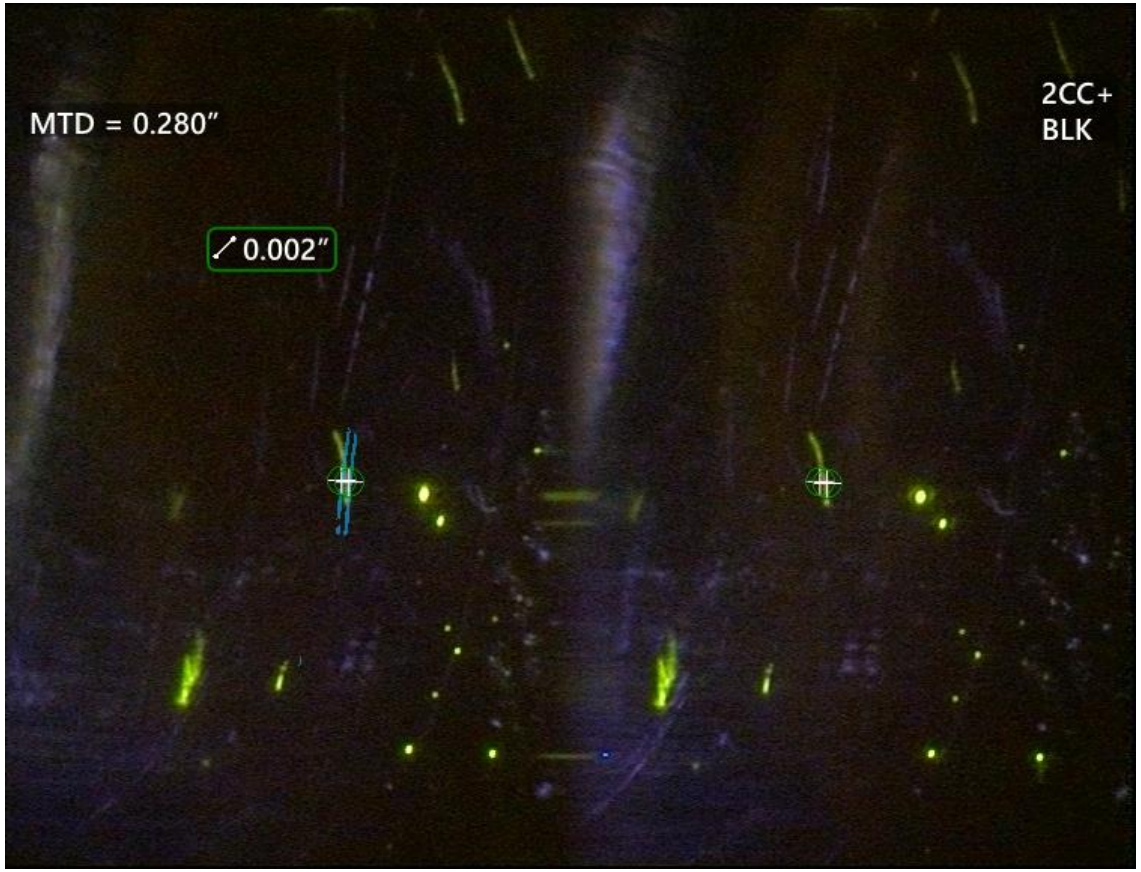
4. WL: Less than 2 fc White Light on target
5. Res: At least 3.17 lp/mm resolution (USAF-1951 G1/E5)
6. Res: Accurate to within ±0.002”
   - *Capable of resolving cracks of 10 µm (0.0004 in)*

Group 1, Element 5




Fluorescent USAF 1951 Test Target

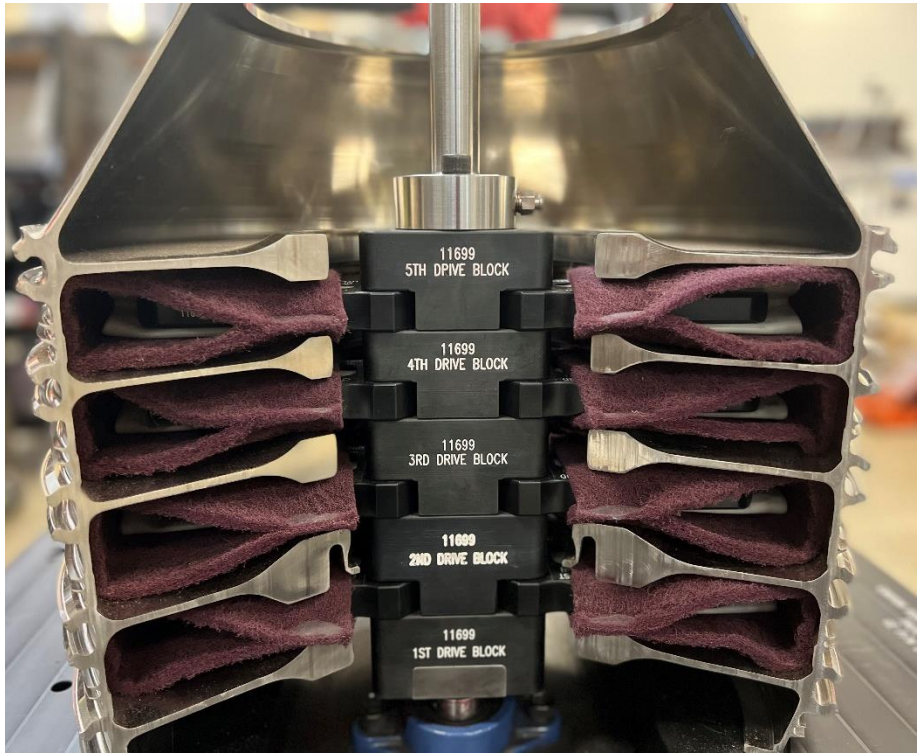
# Typical Deep Well Spool UV Inspection Image

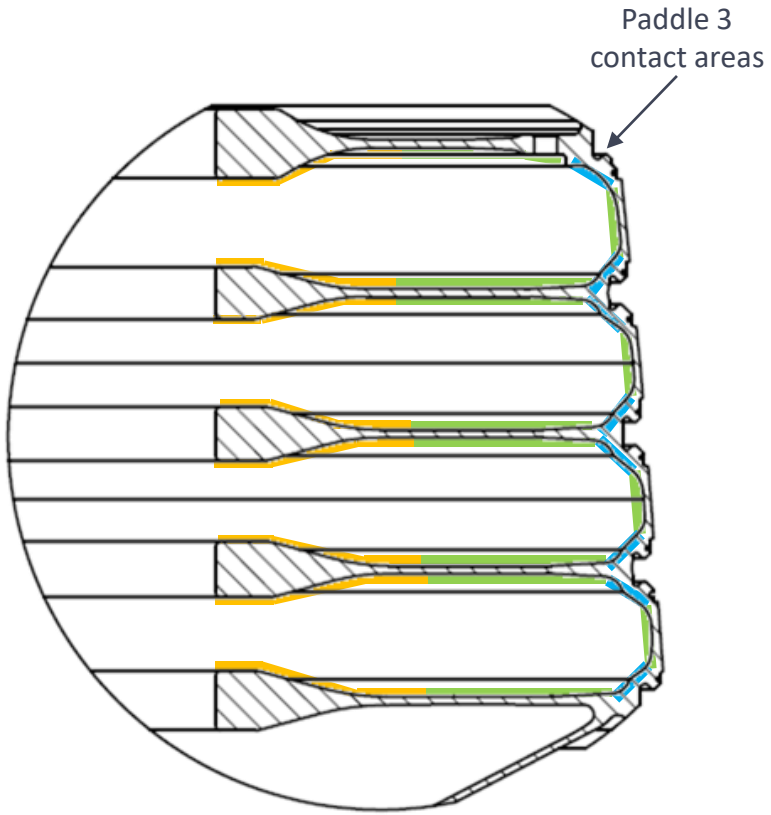




8.4mm Forward Black Stereo Tip
0.280" tip-to-target

# Paddle Designs

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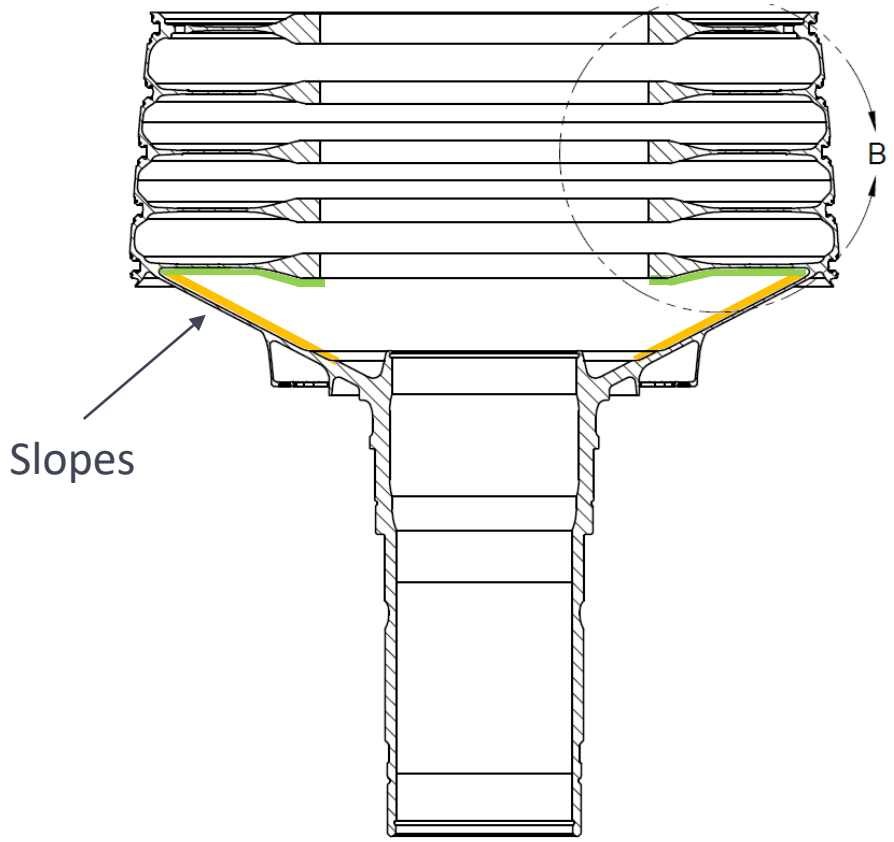
| Paddle Design 1 | Spacer arms and Webs |
| Paddle Design 2 | Bore Face |
| Paddle Design 3 | Radius |

Paddle and corresponding contact surface

# Difficult areas and Specialty Paddles

- Internal slope area
  - Typical for parts with shaft
  - Incredibly difficult to access
  - Causes significant scan interruptions
  - >30hr scans
- Small components
  - Bore size access limitations
  - Spacer arm spacing too narrow for manual access



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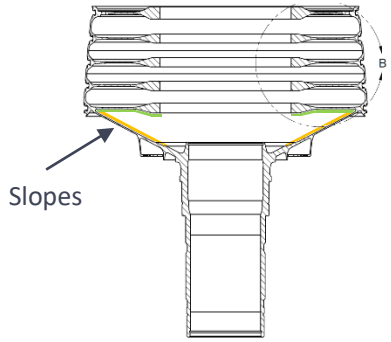


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Compliant Paddle Design for Cones

- Small components
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